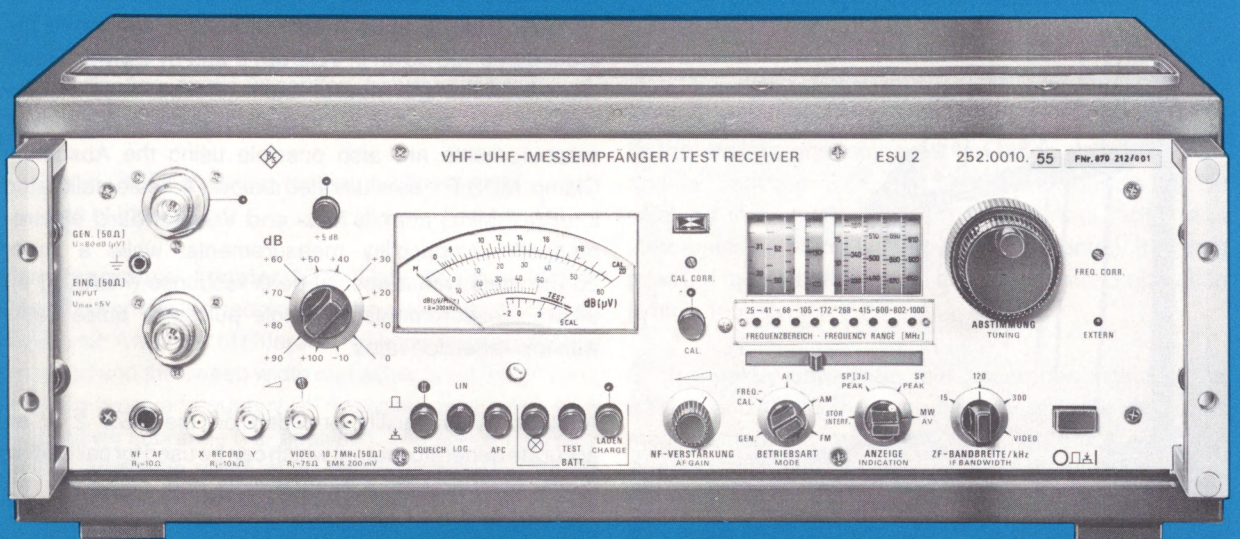
ROHDE&SCHWARZ

ESU 2

VHF-UHF TEST RECEIVER

25 to 1000 MHz

−10 to +120 dB(μV)



The programmable ESU 2 – it can be used as a self-contained test receiver, as a system component or in mobile applications.

APPLICATIONS

Field-strength measurements using test antennas

Radio interference measurements acc. to CISPR publ. 2 and 4 and VDE 0875

Interference measurements acc. to MIL and VG standards

Radiosurveillance and monitoring, remote frequency measurement

Selective voltage measurements in test and development labs

SPECIAL FEATURES

Wide measurement range: −10 to +120 dB(μV)

High accuracy: error ≦ 1 dB

Rapid automatic voltage calibration

Average, peak, VDE- and CISPR-weighted responses

Generator output for testing 2-ports

AC or battery operation

May be used with frequency controller and panoramic display adapter

All functions programmable

Extensible to automatic test assemblies

Data sheet
252001
E – 1

Characteristics and Uses

The manually and remotely controllable VHF-UHF Test Receiver ESU 2 is designed for the measurement and demodulation of AM, FM and pulse-modulated signals and of interference in the frequency range 25 to 1000 MHz. Used alone, or in combination with other equipment, the ESU 2 forms the basis for a multitude of measurements.

By itself, the ESU 2 is a top-class **RF voltmeter** – add the 25-to-300-MHz clamp-on probe and it can also measure RF current from −30 to +100 dB(μA).

The **VHF-UHF Field-strength Meter HFU 2** is a combination of the ESU 2, a 25-to-80-MHz broadband dipole, an 80-to-1300-MHz log-periodic antenna, mast and tripod. The overall measurement band is 25 to 1000 MHz – for details see Data Sheet 253001 and Fig. 1.

As a **system component** the ESU 2 can easily be used with a frequency controller, a panoramic adapter, recorders and test assemblies (Figs. 3, 4, 5).

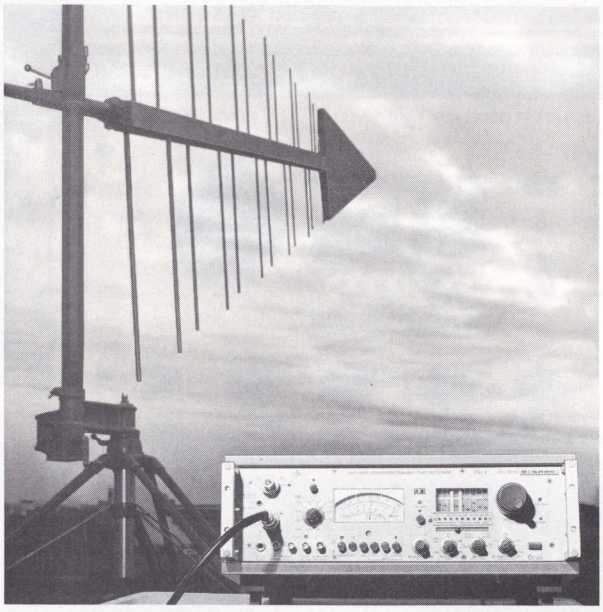


Fig. 1 VHF-UHF Field-strength Meter HFU 2 (corresponding broadband dipole not shown)

High RF-input sensitivity and linearity, together with an internal calibration standard, make for unambiguous and precise measurements. A close-tolerance attenuator extends the linear 20-dB meter range to give a **measurement range of −10 to +120 dB(μV).**

In **test and development laboratories** the ESU 2 will prove to be a most versatile selective voltmeter, offering many alternative ways of evaluating each input. The possibility of using both manual and programmed operation simultaneously will greatly speed up repetitive measurements; they can be carried out partly and fully automatically.

The ESU 2 is also suited for measurements on **TV systems,** including **CATV installations.** The peak-response permits direct measurement of the sync-peak rms vision-carrier level independently of the picture content. Using the average-value indication, the audio carrier and the noise level can be measured to obtain the signal-to-noise ratio. The two direct-coupled AM-demodulator outputs are particularly useful for measuring hum- and cross-modulation of the pilot carriers in cable TV networks.

The ESU 2 incorporates a weighting circuit as required for **radio interference measurement** according to the procedures laid down in **VDE 0875** and by **CISPR.** Radio noise field-strength measurements can be made with the help of the antennas mentioned earlier. RFI power measurements are also possible using the Absorbing Clamp MDS-21 as illustrated below. A scale calibrated in dB(μV/MHz) permits **MIL- and VG-standard** electromagnetic-compatibility measurements, while a linear 20-dB scale with a special peak response (PEAK [3 s]) allows measurements on single pulses or pulse trains with low repetition rates.

Another useful facility provided on the ESU 2 is an accurate generator output which can be used for calibration during field-strength measurements and, especially, for **evaluating 2-port networks** (attenuation up to 90 dB – gain up to 40 dB). When the receiver is used with the Panoramic Adapter EZP (see page 3) for swept subrange measurements it is also possible to sweep-test 2-ports.

The test receiver can be switched over to **"remote frequency measurement"** via the rear remote-control inputs, the RF input signal being stabilized to 20 mV EMF and brought out at the generator output without frequency shift. The signal is filtered in accordance with the selected IF bandwidth. The signal frequency can be displayed on a frequency counter connected to the ESU 2.

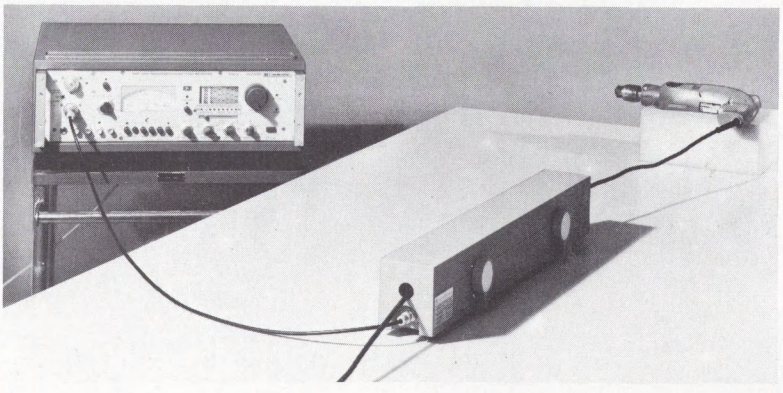


Fig. 2
Radio noise power measurement using ESU 2 and MDS-21

In many practical situations, notably field-strength measurement, it is important to have an instrument which is not reliant on an AC supply. The ESU 2 provides this essential independence in the form of a **battery unit** which mounts directly on the rear panel of the cabinet model. It is also possible to power the ESU 2 from an external **24-V battery.** Thanks to the RF-tight case and the battery pack, the cabinet model is well screened against interfering electromagnetic fields. It can therefore be used for measurements on very intense fields.

Auxiliary instruments (Fig. 3)

When used together with the **Frequency Controller EZK** (Data Sheet N 6-258/255 001) the ESU 2 offers the following possibilities.

Display of the manually set reception frequency with a resolution of 1 kHz.

Stabilization of the reception frequency and quasi-continuous tuning in steps of 100 Hz.

Digital (BCD) frequency setting via the remote-control input of the EZK.

The **Panoramic Adapter EZP** (Data Sheet N 6-257/254 001) permits the spectrum of the received signal to be displayed. A number of different resolution bandwidths are provided and the sweep width can either be up to ±1 MHz from the receive frequency (IF analysis) or as much as a full receiver subrange (RF analysis). The spectral display has an amplitude range of 70 dB (logarithmic) or 20 dB (linear). In the RF analysis mode the combination thus functions as an analyzer with tuned preselection. The **Radiomonitoring Recorder ZSG 3** can be connected at outputs provided on the EZP to produce a permanent record of band occupancy as determined by the ESU 2.

It is also possible to plot voltage or field-strength spectra by connecting the **X-Y Recorder ZSK 2** to the ESU 2.

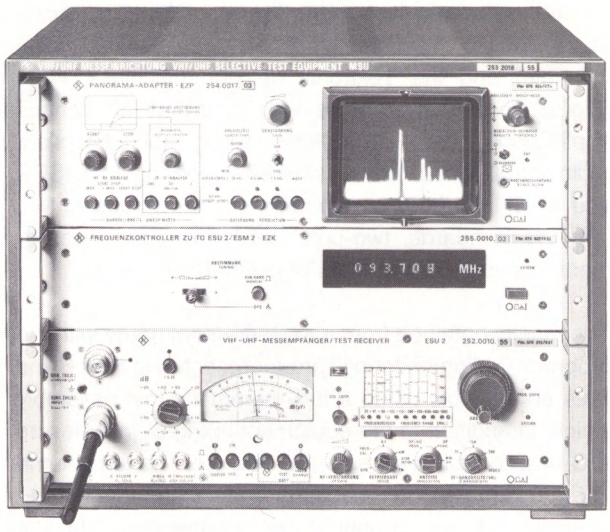


Fig. 3 VHF-UHF Selective Test Equipment MSU comprising the ESU 2 and the separately available units EZP (top) and EZK

Programming

In AC supply operation, all functions of the ESU 2 can be set externally via two rear-panel inputs. This also applies to the digital frequency selection when using the Frequency Controller EZK. The front-panel controls can be disabled individually by the remote-control facility and their functions be replaced by external control. It is thus possible to use both manual and programmed operation simultaneously.

Such a **partly automatic test assembly,** including the ESU 2 and the EZK, is particularly suitable for series measurements in radiomonitoring (see Fig. 4 and Data Sheet 252 010). In addition to the reception frequency, the IF bandwidth, the indicating mode, the operating mode and the command for a level calibration procedure are stored on a punched card. After the punched card has been introduced into the Card Reader PCL, the test assembly is automatically preset.

Setting of the input attenuator and reading of the measured value are effected by the operator.

Fig. 4
Partly automatic test assembly made up of ESU 2, EZK, Card Reader PCL (left) and Code Converter PCW (top) for adaptation to the IEC bus

A **fully automatic test assembly** is obtained by means of the ESU 2, the EZK, an IEC-bus-compatible digital voltmeter and the Tektronix desktop calculator 4051 (Fig. 5). Extensive software with programs for various applications, such as radiomonitoring and detection, radio interference measurements according to CISPR and VDE, interference measurements according to MIL and VG standards, two-port and harmonics measurements is available (see Data Sheet 252011).

The results obtained from a measurement made with the program "radiomonitoring" are represented in Figs 6 and 7 as an example using a fully automatic test assembly which, in addition to the equipment in Fig. 5, includes an IEC-bus-controllable frequency counter. The left column in Fig. 6 contains the reception frequencies (nominal frequencies of the strongest VHF transmitters at the receiving station Munich) fed into the calculator as a data record, the next column represents the measured input levels of the ESU 2, and the third column covers the measured values of the reception frequencies. Their deviations from the values set are specified in the fourth column. Prior to measurement, the date and time stated in the headline are input manually after command by the calculator.

Fig. 7 is a graphical presentation of the measured level values (listed in Fig. 6) against the frequency.

In both test assemblies, the ESU 2 and the EZK are adapted to the IEC bus by means of the Code Converter PCW, thus permitting an extension by IEC-bus-compatible measuring instruments. Digital (and analog) control of the ESU 2 is possible via separate input units. The remote-control inputs also allow master-slave operation of several ESU 2 (active remote control).

Description

The adoption of hinged chassis and plug-and-cable connected subassemblies makes the ESU 2 particularly easy to maintain and service. The reception range of 25 to 1000 MHz is covered in nine subranges using a double-conversion technique. Depending on the particular subrange, the first intermediate frequency is either 199.3 or 339.3 MHz. The 2nd IF is 10.7 MHz in all subranges.

The **RF-input attenuator** is a 10 dB/step motorized unit. The same unit connects the level- and frequency-calibration signals to the input to the **varactor-tuners,** one for each subrange.

The output of the first local oscillator is applied to the **calibration generator** where an extremely accurate calibration signal is produced. It is also available at an output to the **Frequency Controller EZK,** where the reception frequency can be displayed.

The **crystal-controlled second local oscillator** converts the signal to the 2nd IF, after which three different processing paths are available.

1. By way of a **wideband** (approximately 1 MHz) **IF amplifier** and an amplitude demodulator the signal is made available at the VIDEO output. The IF gain of this path can be varied over about 70 dB.

2. The signal can be applied to the **Panoramic Adapter EZP** via a rear-panel output.

3. The principal **2nd-IF amplifier** has filters for 15, 120 and 300 kHz. The signal then passes to the gain-control and **demodulation stages.**

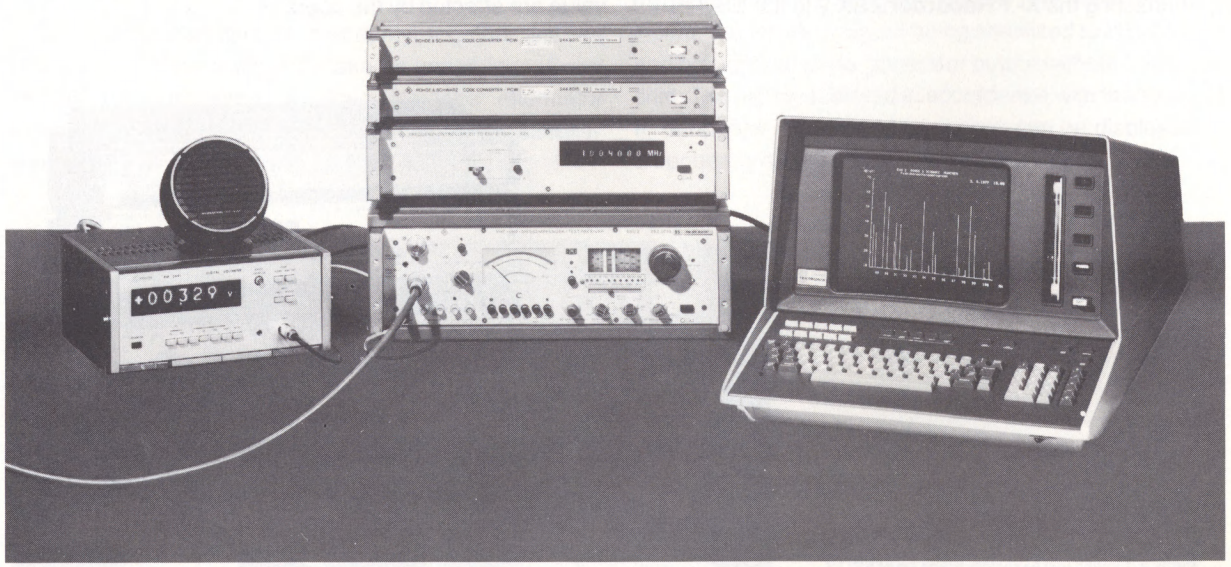


Fig. 5 Fully automatic test assembly consisting of ESU 2 and Frequency Controller EZK (each adapted to the IEC bus with a Code Converter PCW), Tektronix desktop calculator 4051 (right) and digital voltmeter (left)

ESU2 ROHDE & SCHWARZ MUENCHEN
Radio monitoring(list of DATA)
12-1-1977 3.30 pm

receiver-frequency/MHz	level/dB(uV)	measured frequency/MHz	frequency-difference/kHz
88.4	51.1	88.400083	0.083
88.7	35.2	88.700002	0.002
89.5	60.5	89.499991	-0.009
89.95	57.8	89.949996	-0.004
90.7	29.9	90.70004	0.04
90.85	40.3	90.849617	-0.383
91.3	57.7	91.300227	0.227
92.5	24.	92.500102	0.102
93.7	56.	93.700302	0.302
94.4	20.1	94.400044	0.044
94.8	39.6	94.800711	0.711
95.1	22.8	95.099902	-0.098
97.3	53.8	97.300038	0.038
97.5	14.2	97.499139	-0.861
98.1	16.1	98.09996	-0.04
98.5	57.1	98.500292	0.292
99.	37.5	99.000327	0.327
99.9	19.9	99.899902	-0.098
100.4	24.7	100.399845	-0.155

Fig. 6
Values obtained from a level and remote frequency measurement in the VHF range (place of measurement: Munich)

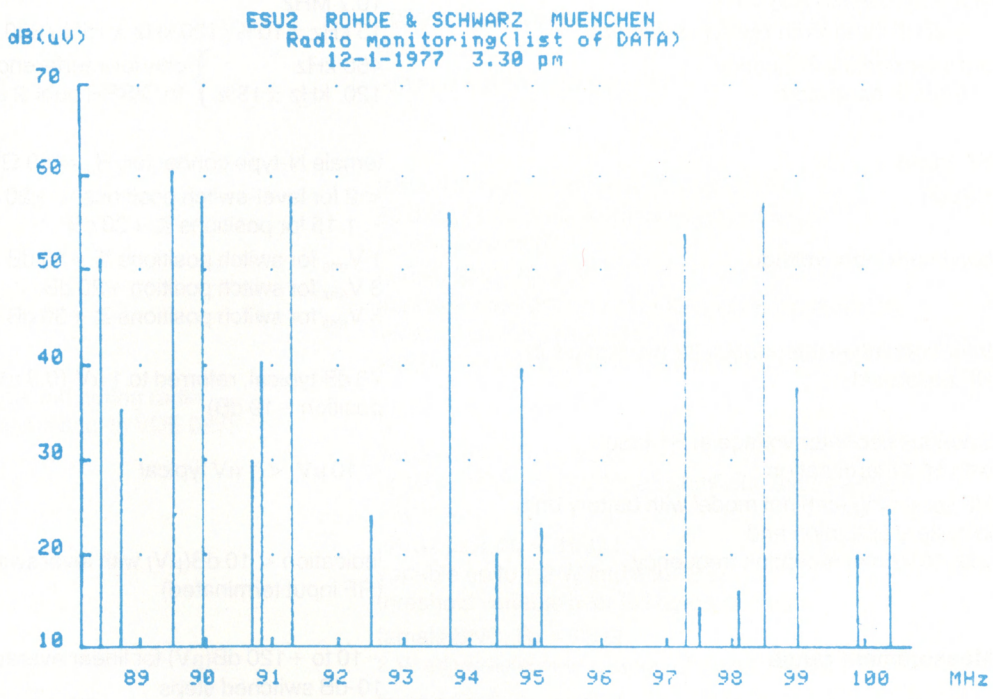


Fig. 7
Graphical presentation of the level values in Fig. 6

When the pushbutton for **automatic level calibration** is pressed, the gain of the entire amplification chain is brought to the correct value by trimming the gain of the 2nd-IF amplifier. In the **LIN** (20 dB) mode the meter indicates the detected output signal; in the **LOG** mode a feedback loop is formed so that the IF signal level is kept constant, the control voltage being logarithmized and indicated on the meter.

The threshold of the **squelch** circuit is adjustable; the squelch can also be switched in or out as required. The **A1 demodulator** output is useful for tuning the receiver centre frequency precisely to an unmodulated carrier.

The CISPR **interference weighting** involves a 120-kHz IF bandwidth and a further conversion to 450 kHz. The overload characteristics of the circuit meet the CISPR requirements. Pulse signals can be monitored at the output of an AM demodulator.

A front-panel screwdriver adjustment and a crystal-controlled marker generator allow precise **calibration of the frequency scale** at 10-MHz intervals.

All commands are processed by the internal **logic circuitry** which then executes them, inhibiting meaningless combinations and thereby greatly reducing the likelihood of errors.

Specifications

Frequency range	25 to 1000 MHz[1]) in nine subranges
Subranges	24 to 42/40 to 70/67 to 110/100 to 175/170 to 270/265 to 420/410 to 605/595 to 805/800 to 1000 MHz
Frequency setting	range selection using slide switch; tuning by means of coarse/fine drive
Range indication	sliding mask and LEDs
Frequency indication	illuminated drum scale; total scale length: 2 m
Resolution	about 100 kHz/mm in the lowest range; about 1 MHz/mm in the highest range
Setting error (after frequency calibration)	$< 1 \times 10^{-3} \times f_{ind} + 100$ kHz
Built-in marker generator	multiples of 10 MHz $\pm < 5 \times 10^{-6}$
AFC	switch-selected
Noise figure	8 dB typ. up to 400 MHz 10 dB typ. up to 1000 MHz
Image-frequency rejection	> 70 dB
IF rejection	> 80 dB
1st intermediate frequency	199.3 MHz for subranges 24 to 42/40 to 70/265 to 420 MHz; 339.3 MHz for all other subranges
2nd intermediate frequency	10.7 MHz
6-dB IF bandwidth (switch-selected)	15 kHz ±10% / 120 kHz ±15% / 300 kHz ±20%
3rd intermediate frequency	450 kHz } only for interference measurements acc.
6-dB IF bandwidth	120 kHz ±15% } to CISPR publ. 2 and 4 and VDE 0875
RF input	female N-type connector, $R_{in} = 50\ \Omega$[2])[3])
VSWR	< 2 for level-switch positions < +20 dB < 1.15 for positions ≧ +20 dB
Maximum input voltage	1 V_{rms} for switch positions ≦ +10 dB 3 V_{rms} for switch position +20 dB 5 V_{rms} for switch positions ≧ +30 dB
Intermodulation attenuation for two signals in RF passband	70 dB typical, referred to 1 µV (0.3 µV in level switch position −10 dB)
Spurious oscillator voltage at RF input with 50-Ω termination	< 10 µV, < 1 µV typical
RF screening (cabinet model with battery unit) in battery operation and with 10 V/m at reception frequency	indication < 10 dB(µV) with level switch position ≦ +10 dB (RF input terminated)
Measurement range	−10 to +120 dB(µV) for linear average-value mode, 10-dB switched steps
Measurement error (after calibration)	≦ 1 dB for inputs ≧ 1 µV; linear average-value mode
Additional error of logarithmic indication	≦ 2 dB
Indicated noise (15-kHz IF bandwidth)	≦ −13 dB(µV), −16 dB(µV) typical; linear average-value mode

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[1]) An ESU 2 version for 20 to 1000 MHz is available with slightly restricted performance.

Spurious response	at 21.4 MHz
Indication with terminated RF input	< 0 dB(µV) typical

[2]) 60- and 75-Ω versions are also available with modified specifications:

RF input	60-Ω Dezifix B[3])	75-Ω Dezifix B[3])
Additional error in level-switch positions −10/0/+10 dB	0.5 dB	—
Measurement range	−10 to +120 dB(µV)	0 to +130 dB(µV)
Increase in typical noise figure	1 dB	9 dB

[3]) Screw-in adapters are available for easy conversion to other connector standards: ask for data sheet 902 100.

Indication . . . . . analog, illuminated meter scale

Ranges . . . . . 20 dB linear
60 dB logarithmic
40 dB logarithmic (peak-responding)
in dB(μV/MHz) for MIL wideband interference measurements at 300 kHz IF bandwidth
7 dB for interference measurements acc. to VDE 0875 and CISPR

Modes . . . . . average value – linear and logarithmic
peak value – linear
charging time-constant less than IF-filter rise time,
discharge time-constant: 1 s
peak value – logarithmic (for pulse repetition frequencies > 10 Hz)
peak value (3 s) – linear
charging time-constant less than IF-filter rise time,
hold time: 3 s (following first RF pulse),
discharge time: about 5 ms
weighted according to VDE 0876 and CISPR publications 2 and 4

Pulse weighting acc. to VDE 0876 and CISPR publications 2 and 4 . . . . . .

reception frequency	minimum pulse frequency
25 to 200 MHz	0 Hz (single pulse)
200 to 600 MHz	2 Hz (typical value)
600 to 1000 MHz	10 Hz (typical value)

Types of demodulation . . . . . AM and FM (A1, A3 and F3)

Outputs

Generator (switched) . . . . . female N-type connector, $R_s = 50\ \Omega$ [1)] [2)]
EMF . . . . . 86 dB(μV) ±0.5 dB at frequency to which receiver is tuned

IF – 10.7 MHz . . . . . female BNC, $R_s = 50\ \Omega$
EMF . . . . . approximately 200 mV in LOG and at full-scale LIN
6-dB bandwidth . . . . . 15 kHz / 120 kHz / 300 kHz (according to selected IF bandwidth of receiver)

IF – 450 kHz (only connected during radio interference measurements acc. to VDE 0875 and CISPR) . . . . . female BNC, $R_s = 50\ \Omega$
EMF (at full scale) . . . . . approximately 15 mV for an unmodulated sinewave
6-dB bandwidth . . . . . 120 kHz

AF . . . . . JK-34 jack, $R_s = 10\ \Omega$
Output power . . . . . variable up to 1.2 W into 8 to 16 Ω
Squelch (switched) . . . . . threshold variable over full range of meter

Video – 0 to 500 kHz . . . . . female BNC, $R_s = 75\ \Omega$
EMF . . . . . 2 V, adjustable over a range of about 70 dB

AM demodulator – 0 to $\frac{B_{IF}}{2}$ Hz . . . . . female BNC, $R_s = 75\ \Omega$
EMF . . . . . approximately 1 V in LOG and at full scale in LIN

FM demodulator – 0 to $\frac{B_{IF}}{2}$ Hz . . . . . female BNC, $R_s = 75\ \Omega$
EMF . . . . . about ±1 V for a deviation of ±125 kHz from the tuned centre frequency

Recorder . . . . . female BNC, $R_s = 10\ k\Omega$
X (frequency) axis . . . . . 0 to 10 V in each subrange
Y (signal-level) axis . . . . . 0 to 5 V proportional to meter reading

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[1)] 60- and 75-Ω versions are also available with modified specifications:
Generator output . . . . . 60-Ω Dezifix B[2)] 75-Ω Dezifix B[2)]

[2)] Screw-in adapters are available for easy conversion to other connector standards: ask for data sheet 902 100.

VHF-UHF TEST RECEIVER

General

Nominal temperature range	0 to +40 °C
Working temperature range	−10 to +40 °C
Storage temperature range	−25 to +70 °C (without NiCd cells)
Connector for Panoramic Adapter EZP (with 2nd-IF output)	multiway connector (Cannon)
Connector for Frequency Controller EZK (with 1st-LO output)	multiway connector (Cannon)
Connectors for remote control (with analog and digital inputs and outputs)	two 50-way connectors (Amphenol)
Power requirements	
AC supply	115/125/220/235 V $^{+10\%}_{-15\%}$, 47–420 Hz (65 VA)
Battery operation	
Battery Unit (cabinet model only)	holds 20 NiCd cells, acc. to IEC KR 33/61
Operating time	approx. 3.5 hours, temperature-dependent
Charging time (using internal charger)	approx. 14 hours
External battery	22 to 28 V, 1 to 1.5 A; negative earth
Charging current delivered by internal charger	approx. 400 mA
Overall dimensions (W x H x D)	
19″ rackmount	483 mm x 133 mm x 507 mm
cabinet model	492 mm x 195 mm x 556 mm
Weight	
19″ rackmount	22 kg
cabinet model	27 kg with Battery Unit empty; 30 kg with Battery Unit full

Order designation ▶ VHF-UHF Test Receiver ESU 2

	19″ rackmount	cabinet model
50-Ω version with N-type connector (standard version)	252.0010.54	252.0010.55
Version 20 to 1000 MHz	252.0010.58	252.0010.59
50-Ω version (Dezifix B, adaptable)	252.0010.51	252.0010.52
60-Ω version (Dezifix B, adaptable)	252.0010.61	252.0010.62
75-Ω version (Dezifix B, adaptable)	252.0010.71	252.0010.72

Accessories supplied

Power cable 025.2365.00, battery cable 252.0084.00 and (for cabinet model only) battery unit 252.7443.00 (without batteries), manual.

Recommended extras

For cabinet model: 20 NiCd cells RS 4 as per IEC KR 33/61 order designation per cell	252.6001.00
Headphones (with Plug PL-55)	110.2959.00
Plug PL-55 for AF output	019.0487.00
Mating connector for remote-control inputs and outputs (2 required)	018.5904.00
RF Clamp-on Current Probe ESU-Z (25 to 300 MHz)	100.1137.02
RF Cable for connection to ESU 2	204.1090.02
Absorbing Clamp MDS-21 (30 to 1000 MHz)	194.0100.50
BNC female – N male adapter (for Current Probe and MDS-21)	118.2812.00
Panoramic Adapter EZP	254.0017.02
Radiomonitoring Recorder ZSG 3 (used with EZP)	242.6015.92
Connecting Cable (EZP – ZSG 3)	251.9488.00
Frequency Controller EZK	255.0010.02
XY Recorder ZSK 2	290.2016.04
Antennas for field-strength measurements in HFU 2 data sheet	253001
Accessory units for card-controlled operation in data sheet	252010
Accessory units for operation by desk calculator control in data sheet	252011

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